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On the consequences of university patenting: What can we learn by asking directly to academic inventors?

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Abstract

This paper examines the consequences of university patenting by using an original source of information: The point of view of French academic inventors, i.e. French university professors who are also inventors of European patents. Via a survey we collected information about 280 French academic inventors. This enables us to put forward new insights with respect to the effect of university patenting on the diffusion of scientific research, incentives to do basic research, commercialization of university inventions and access to upstream knowledge. In particular, the study suggests a tradeoff between enabling the transfer of university inventions to industry in some sectors and delaying the dissemination of scientific research. On the one hand, most academic inventors acknowledge a lag in their publication process directly attributable to the patent application but, on the other hand, in life science disciplines a large majority of respondents who have had one of their inventions commercialized, believe that this would not have been the case had a patent not been there.

Keywords: University patenting, open science, intellectual property rights, technology transfer, university-industry relationships, Bayh-Dole Act.

JEL Classification: O3

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1. Introduction

This paper deals with the role of patents in academia. Specifically, it focuses on the consequences of university patenting on the dissemination of scientific knowledge, transfer of universities inventions to industry, access to upstream research, incentives scientists have in order to undertake basic research and the culture of "open science". Although these issues have been widely dealt with in the literature (Henderson *et al.* 1998; Mowery *et al.* 2001; Stephan *et al.* 2001; Mazzoleni and Sampat 2002; Nelson 2004; Buenstorf 2006; Eisenberg 2006; Geuna and Nesta 2006; Sampat 2006; Verspagen 2006; Fabrizio 2007; Murray and Stern 2007), we bring new insights by using an original source of information: The point of view of French professors who have been involved as inventors in a European patent application (academic inventors in the following). Via a survey conducted in April and May 2008, we collected information about 280 French academic inventors.

The traditional model of public research (the open science model) views universities as being devoted to provide a reservoir of public knowledge in which firms can tap to develop industrial applications. In this sense, patents had historically almost no place in the "republic of science" (Polanyi 1962), which relied on rapid and free publications of research results (Bush 1945; Nelson 1959; Dasgupta and David 1994; Stephan 1996). Yet, during the past three decades one has observed a strong and steady trend towards university patenting. If the Bayh-Dole Act[2] (1980) in the US symbolizes this rupture, nowadays this trend can be observed worldwide. Universities and public research organizations all over the world massively patent the outcome of their research (Mowery *et al.*, 2001; Mazzoleni and Sampat 2002; Cesaroni and Piccaluga 2002; Geuna and Nesta 2006; Azagra-Caro *et al*. 2006; Carayol and Matt 2007; Lissoni *et al.* 2007)[3].

Scholars have extensively discussed the effects of this trend on social welfare. On the one hand, it is argued that patenting academic invention is necessary to facilitate technology transfer and to decrease the rate of public inventions that remain on the shelves of universities (The Bay-Dole Act hypothesis). This argument relies on the assumption that universities inventions must be appropriable to induce firms to commercialise them. In the absence of property rights, universities inventions would not provide firms with any competitive advantage over their rivals, which would deter them from adopting products and processes developed within universities (Jensen and Thursby, 2001; Verspagen 2006). Moreover, it is

[2] An important literature has emerged recently around the issue of the Bayh-Dole Act and its consequences on US academic research (Mowery *et al.* 2001; Mowery and Ziedonis 2002; Mowery *et al.* 2004; Sampat 2006). It is generally agreed that although the Bayh-Dole Act has accompanied the trend, it was not the factor which triggered university patenting, since many important US universities started to patent their research in the 70s (see for instance Colyvas 2007, for a detailed story of the Cohen-Boyer patent).

[3] According to USPTO statistics, US universities owned 1.1% of US owned patents issued between 1969 and 1984. Since 1984 this share has increased continuously and was equal to 4.8% in 1999 (Mazzoleni and Sampat 2002). This increase in university patenting has mechanically induced an augmentation of licensing of university patents. An inquiry of the AUTM (Association of University Technology Managers) shows that in 1991 US universities had granted 1043 licenses to firms, while the same universities had granted more than the double (2351) in 1998. Yet, Mowery *et al.* (2001) notice that most licenses granted by US universities contained somehow exclusive arrangements. In parallel to this increase of patenting, US universities have also adopted a more aggressive use of their patent portfolios. Some of them do not hesitate to enforce their patents in court. Although not as aggressive as in the US yet, a similar trend can be observed in Europe. In France, most public research organizations are now engaged in an active patenting policy. In 2004 the CNRS was ranked number six with respect to French patents held by French organizations. INSERM and INRA were also ranked high (INPI, 2005). Similarly, French universities are now patenting more systematically their research (Azagra-Caro *et al.* 2006; Carayol and Matt 2007; Lissoni *et al.* 2007).

also often argued that patenting universities research is a way to close the gap between universities and corporate research (Crespi, 1998). Patents would provide a common language and a common practice, which would help to develop links between universities and industry. University patents could therefore help to anchor universities within industrial networks. Finally, allowing universities to own patents may also enable them to increase their financial resources through licensing and industrial research contracts (Geuna and Nesta 2006).

But on the other hand, university patenting can also have numerous "unintended effects" (Davis *et al.* 2008). For instance, it is feared that it might increase the cost of accessing upstream research, decrease the incentives to do basic, non-patentable research, decrease the trust among public researchers and thus undermine the culture of open science, decrease the teaching quality of university professors, decrease the publication rate of researchers, etc. (Mowery et al., 2004; Geuna and Nesta 2006). Overall, it is feared that academic patents undermine the construction and availability of a platform of scientific, upstream knowledge on which applications may flourish (David 2003; Nelson 2004). In this sense, university patenting would seriously damage the pace of innovation in the long run.

Many empirical studies have documented some of the aspects of university patenting. There are converging results, for instance, on the fact that university patenting does not decrease the performance of researchers, measured in numbers of publications (Stephan *et al.* 2001; Van Looy *et al.* 2006; Carayol and Matt 2007). Yet, survey based studies almost all indicate that academic patenting and licensing do affect the norm of disclosure, lead to higher levels of secrecy and participate to delay publication (Blumenthal et al., 1997 ; Louis et al., 2001 ; Campbell et al., 2002). It has also been demonstrated that in some specific sectors (pharmaceuticals, biotechnology) university patenting does facilitate technology transfer from university to industry (Mansfield, 1986; Levin et al., 1987, Cohen et al., 2002). However, we lack general evidence on the social desirability of university patenting.

This paper complements the existing literature by proposing a new source of data to study the consequences of university patenting. We asked directly to academic inventors. Those are indeed likely to be the best persons to know about the consequences of their patenting activities. To gather the information, we sent a questionnaire (via email) to French academic professors (not full time researchers), who had formerly been identified as inventors in a European patent application. Previous studies had identified 1228 confirmed French academic inventors (Lissoni *et al.* 2007). Out of this number we had been able to collect 280 responses, i.e. a response rate of over 20%. This sample is reasonably representative of the mother population of confirmed French academic inventors.

Relevance of questionnaire based studies is always limited by the fact that we do not work on objective figures but on what respondents tell us. And respondents may not always tell the truth, which can lead to multiple biases. In our study, most respondents seem to be patent enthusiastic, thus exaggerating sometimes the merit of university patenting and diminishing the problems (most of the time unconsciously). Yet, in the case of university patenting, where objective figures are rare, our study has the merit of providing new and rich qualitative insights.

The first statistical analysis of the responses put forward two important results: First, university patenting induces a systematic delay in the publication process. In most cases academic researchers acknowledge a lag in the date of publication of their research directly attributable to the patent application. This lag is sometimes short (less than 6 months) but in

half the cases it amounts to more than one year and it can even exceed 2 years. In some extreme cases publication is not allowed at all. Some researchers also often acknowledge a control of the partner firm over the content of their publications. The second important result deals with the Bayh-Dole hypothesis, which is confirmed only in some scientific disciplines. This hypothesis seems to be especially relevant in life science sectors such as biology, pharmaceuticals and medical sciences, but less so in engineering. In life science sectors, most of the researchers that are inventors of an invention that has been commercialized consider that the patent has played a central role in this commercialization. This is specifically true for pharmaceuticals, for instance, where 100% of the respondents considered that their invention would not have been transferred in the industry had a patent not been there. With respect to the consequences of university patenting, our study suggests therefore a trade-off between easing the commercialisation of university inventions in some sectors and delaying the dissemination of public knowledge.

Section 2 reviews the existing literature on the consequences of university patenting. Section 3 provides a description of our sample and compares it with the mother population of confirmed French academic inventors. It specifically discusses the possibility of a bias due to the methodology used (declared and not revealed preferences). In section 4 we display the results of the survey. Section 5 concludes.

2. Literature review

Consequences of university patenting have been extensively discussed in the literature. We provide here an overview of possible effects that have been identified. Yet, this survey does not pretend to provide an exhaustive picture of all the consequences of university patenting and licensing.

Dissemination of academic knowledge

Academic patenting may retard the dissemination of scientific research. In France, as in other European countries, inventions must be kept secret before applying for a patent. Any disclosure of the invention will add to prior art and therefore automatically prevent the granting of a patent. Inventors who want to patent must therefore implement a strict policy of secrecy before the application. With respect to the academia, this suggests that allowing and encouraging university to patent may retard the disclosure of university inventions. Public research organizations that want to apply for patents must delay the publication of their research related to the invention before a priority patent is filed. Since, the preparation of a patent application can take a long time, the lag in the dissemination of academic research can sometimes be important. In the US this effect is attenuated by the existence of a one year "grace period" that gives right to inventors to apply for a patent until one year after the first disclosure of the invention (Franzoni and Scellato 2007).

Empirical studies do not provide convergent result with respect to the impact of university patenting on the diffusion of academic knowledge. Most econometric studies show that patents and publication are complement rather than substitutes, i.e. scientists who patent the most are also those who publish the most (Stephan *et al.* 2001; Buenstorf 2006; Van Looy *et al.* 2006; Carayol and Matt 2007). Van Looy *et al.* (2006) even find that academic patenting may reinforce the publication activity of scientists. This result can be interpreted, with all the necessary reservations, as evidence that academic patenting does not reduce the dissemination of academic research, as long as one accepts to measure the latter by the number of scientific

publications. But, on the other hand, the limited qualitative evidence that exist suggests that patents do delay the publication process. Using a questionnaire based survey, Webster and Packer (1997) conclude that university patenting can compromise the dissemination of academic research. Similarly, a report of the European Commission (2002) directly addresses the question of the publication delay attributable to university patenting. Results show that a majority of respondents acknowledged to some extent a publication delay (see Geuna and Nesta 2006, for an interpretation and a critic of the finding of the EC report). Surveys led in the US also suggest a significant impact of academic patenting and licensing on the speed of dissemination of research results (Blumenthal et al., 1997; Louis et al., 2001; Campbell et al., 2002). Finally, Breschi et al. (2005) use a methodology to match patent/publication pairs of Italian researchers and conclude that they "cannot exclude the existence of some 'publication delay effect'" (Breschi et al. 2005, p. 18-19).

Commercialization of academic inventions

Academic patenting may facilitate the transfer of university inventions to industry. This is the so-called Bayh-Dole hypothesis, named after the Bayh-Dole Act (1980) in the US. According to Senators Bayh and Dole, the two initiators of this law, allowing universities to patent their inventions should increase technology transfer and industrial exploitation of academic research. Without patents, many inventions developed in academia would remain on the shelves of the university because "what is available to everybody is of interest to no one" (Mazzoleni and Sampat 2002, p. 237)[4]. Firms have no incentives to commercialize inventions from universities, to undertake important investments to bring them to the market if, once this is done, they cannot appropriate the invention. Patents give an element of exclusivity over the invention and should therefore facilitate its commercialization (Verspagen 2006).

With respect to this Bahy-Dole argument, important sectoral differences can be expected. Sampat (2006, p. 773), among others, asserts that: "Patents and licenses are considerably more important channels in pharmaceuticals that in other industries". In field such as biotech and pharmaceuticals it is indeed well known that patents are essential to spur the development of new products (Mansfield 1986; Levin *et al.* 1987; Cohen *et al.* 2000). Yet, this may not be the case in other sectors. Mowery et al. (2004) stress the fact that in most sectors there exist other channels to transfer inventions from university to industry and thus the absence of patents does not always preclude the transfer of the invention to the industry. In those sectors "where exclusive licenses are not necessary to ensure commercialization of academic research, exclusivity may reduce the social benefit of the invention" (Mowery et al., 2004, p. 191).

Related to this issue of corporate use of academic inventions, it is often argued that letting university patent their research may help to improve relationships between universities and industry (Crespi 1998). Hellman (2007) suggests, for instance, that university patenting help to signal university research to industry, thus reducing the search costs and fostering collaborations, research contracts, technology transfer, etc. University patents would hence be a way to help university researchers going out of their "ivory tower" and getting closer to the "kingdom of industry". They would ensure that academic scientists share norms similar to those of corporate scientists, which could only improve the links between the two worlds. In a sense, patenting would enable to anchor scientific research within industrial networks.

[4] This argument derives from a statement of a pioneer academic inventor, the chemist F.G. Cottrell who said in 1912: "what is everybody's business is nobody's business" (Cottrell 1912, cited in Mowery *et al.* 2004, p. 59).

Despite the clarity of the theoretical argument, we lack empirical test of this Bayh-Dole hypothesis. An exception is the work of Jensen and Thursby (2001), who study licensing practices of 62 US universities. They argue that, since most university inventions are at a too embryonic stage to be readily commercialized, firms need the collaboration of the inventor. And university patenting and licensing is an efficient mechanism to force scientists' collaborations. It provides a solution to the moral hazard problem faced by firms. They conclude that: "Many inventions are so embryonic that they might remain in the lab without licensing agreements designed to induce collaboration between inventors and licensees" (Jensen and Thursby 2001, p. 241). On the other hands, many authors question the relevance of this argument and rather claim that Bayh-Dole has decreased the quality of university patents (Henderson *et al.* 1998).

Culture of "open science"

University patenting may undermine interactions and free exchanges among scientists. The rise of patents within academia may diminish the collaborations between scientists, thus decreasing the efficiency of scientific communities. Here, university patenting would threaten the culture of open science at its heart. Since around a patent there may be important amounts of money at stake, or at least since scientists may believe that there are important amounts of money, university patenting may decrease the willingness of scientists to share their results and research materials. In this sense, scientists may become more "selfish" and less willing to collaborate and to help colleagues. Yet, as asserted by Verspagen (2006, p. 616), open science "works in an atmosphere of openness and sharing of knowledge, data and research results. It is exactly this open nature of the scientific process that is responsible for much of its success […] Patents may turn this open culture into a more closed one". As stressed above, empirical studies have emphasized that academic patenting and licensing may lead to increased secrecy and decrease the sharing of early research results (Blumenthal et al., 1997; Louis et al., 2001; Campbell et al., 2002).

Furthermore, within the academic community patents are surrounded by ideological considerations, which lead an important part of the community to reject them. It is frequent to hear academic inventors complaining about the low consideration that their colleagues give to their patent attempt. In this sense, scientists who apply for patents may be ostracized within scientific communities, thus also decreasing the rate of exchanges and interactions among communities.

Incentives to do basic research

University patenting may decrease incentives to do basic research[5]. Patents reward applied research. Theoretically basic research cannot be patented since, by definition, they consist of research undertaken without any application in mind, while an invention must have an industrial application in order to be patentable. It is therefore possible that the possibility to patent university research induces an eviction effect of basic research in favor of more applied research. Since the latter becomes more rewarded, scientists may prefer to engage more resources to do applied, patentable research and less to undertake basic, non patentable research[6]. This eviction effect could seriously damage long term growth rate, since a platform

[5] Similarly, university patenting may reduce the incentives to spend time on education. Since teaching becomes relatively less rewarded than doing patentable research, university professors may tend to reduce the time they devote to teaching (Geuna and Nesta 2006).

[6] Yet, this may not necessarily be the case if in the same time scientists devote less time to leisure. In this sense, the introduction of university patent can induce scientists to do more basic and applied research and to take less

of good basic research is a necessary springboard to foster long run economic growth (Nelson 1959; 2004).

This problem is part of a wider issue in economics of science which is the "problem of problem choice" (Carayol and Dalle 2007), i.e. the choice by scientists of their research agenda. One of the pillars of the "the republic of science" is that scientists must be free to choose the problem they want. To ensure the efficiency of the process, no central regulator should oblige scientists to work on some specific topic (Polanyi 1962). Another pillar of the "republic of science" is that scientists decide their research agenda according to the effect on their reputation. This induces scientists to choose not the more remunerating problems to solve but the ones that will increase their reputation, i.e. the more challenging from an intellectual point of view. This, in turn, intends to encourage scientists to devote time and resources to undertake basic research, which is highly valued by the scientific community, and less time and resource to undertake applied research, less valued by the community. Hence, the "republic of science", although likely to do it imperfectly, ensures that scientists have incentives to do basic research although this kind of research yields weak monetary benefits. By introducing patents within the "republic of science", one may reduce those incentives and increase incentives to do applied research.

If we measure the outcome of basic research by the number of publications (which is a poor proxy but also the only serious one that exists) the existence of such an eviction effect is rejected by empirical studies. As already mentioned above, researchers and labs who patent the most are also those who publish the most, which tends to indicate that researchers who are engaged in patentable activities do not do less basic research. However, a bundle of empirical studies also tend to suggest that academic patenting and licensing may shift the focus of academic research away from fundamental to more applied topics. Henderson et al. (1998), for instance, find that the quality of academic patent, measured by the number of forward citations, tend to decline since the early 80s'. A possible interpretation of this finding is a shift of US universities toward more applied research (with a less rich scientific content). Yet, Mowery et al. (2004) do not find evidence of such a quality decline. Similarly, Thursby and Thursby (2002) cannot reject the possibility of a crowding-out effect of basic research. Azoulay *et al.* (2006) also find out that university patenting may induce scientists to shift their research focus on things of more commercial interest. Finally, Gulbrandsen and Smeby (2005) found that in Norway professors who have links with industry tend to describe their research as more applied (see also Geuna and Nesta 2006).

Access to upstream research

University patenting may render access to scientific knowledge more costly. Condition of access to upstream knowledge is a central issue. Since innovation is somehow a cumulative process, knowledge is an input in the process of producing knowledge, which means that it is highly important to preserve as large as possible an access to existing knowledge in order to foster the production of further inventions. This is the basic argument that underlies the existence of the "republic of science", which is based on a quick and free release of scientific knowledge through publications.

Yet, patenting university research gives automatically an element of control to these researches, which may decrease their availability to other researchers. It is feared here that patents might increase the price of access to university inventions, thus decreasing their

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leisure time (Thursby *et al.* 2007). Furthermore, Thursby *et al.*, also suggest that if applied research results in both more applied and basic knowledge, the introduction of university patent has still a more positive effect.

availability to build on and impeding the cumulative process of knowledge production. In fields where many patents are granted, such as biotechnology and electronics, some authors warn against the risks induced by a "patent thickets" (Shapiro 2001), by the emergence of a potential "tragedy of the anticommons" (Heller and Eisenberg 1998) or by a "privatization of the commons" (Nelson 2004). All these expressions suggest that the proliferation of patents in some specific fields may increase the cost of accessing knowledge and of doing science, which in turn would reduce research in these fields.

With respect to the access to scientific knowledge by academic scientists, another potential damage caused by university patenting was raised by Eisenberg (2003), who analyzed the recent rejection by the CAFC in the US of an "experimental use defense" or a "research exception" to Duke University[7]. Historically, academic researchers have always been considered as being unconcerned by patent infringements. As long as their research was undertaken for non-profit motives, for purpose of "idle curiosity" or "philosophical inquiry", they could use patent held by others without having to ask for permission and without having to pay royalties. Yet, this situation may change as shown by the recent Madey vs. Duke decision, which "did not extinguish the experimental use defense entirely, but eviscerated it to the point that it is essentially useless to research universities" (Eisenberg 2003, p. 1019). This decision is in a sense a direct consequence of university patenting. Now that universities are using their patent portfolios more and more aggressively, one may indeed expect to see firms trying to secure their patents and starting to sue universities for patent infringements. By patenting massively and by using their patent portfolios aggressively, universities become a normal player in the patent game and there is no reason to grant them a "research exception". This unintended consequence of university patenting may seriously damage scientific research, which works essentially by reusing research done elsewhere.

By comparing the citation rate of scientific papers before and after a patent is granted, Murray and Stern do find a "robust evidence for a quantitatively modest but statistically significant anti-commons effect" (2007, p. 651) due to academic patenting. Yet, many recent studies in the field of biomedical sciences do not find that patents may impede access to upstream research. They rather put forward other impediments such as control over materials necessary to do research or secrecy. Following Cohen and Walsh (2008) one must indeed make a distinction between legal excludability (which is operated through patents) and practical excludability, which may have little to do with patents (Cohen and Walsh 2008). Specifically, Walsh *et al.* (2007, p. 1184) found that "access to knowledge inputs is largely unaffected by patents". Out of the 381 academic scientists they interviewed "none reported having to stop their research due to the existence of third party patents" (Walsh, Cohen and Cho 2007, p. 1190). Hence, "although patents may confer a legal right to exclude, it does not confer "practical excludability" in academic research sittings" (Cohen and Walsh 2008, p. 13)[8].

[7] *Madey* v. *Duke University*, 307 F.3d 1351 (3 October 2002).

[8] In the case of biomedical science, the authors argue that access to upstream research is mainly restricted due to the use of secrecy or to the control firms have over their materials and not due to aggressive patenting strategies. For instance, researchers may merely refuse to share intermediary results and materials to reproduce experiments. Those central inputs to do science, such as private data, proteins, drugs, research tools, although not patented, are therefore made unavailable to other scientists. This is especially true when these intermediary materials are difficult to replicate. Cohen and Walsh find that most researchers in the biomedical field have already made requests to other colleagues that have been denied.

3. Description of the dataset and representativeness

Via a survey conducted in April and May 2008, we collected information about 280 French academic inventors[9]. This sample stems from a wider population of French academic inventors identified in a previous study (Lissoni *et al.* 2007). By French academic inventors we mean French university scientists (i.e. Maître de Conférences [equivalent to associate professors] and University professors) active in a French university in 2004 and mentioned as inventor in at least one European patent applied for after 1993. Within a European project entitled KEINS[10], we were able to identify 1228 confirmed French academic inventors, by matching the European Patent Office (EPO) database of inventors since 1993 with the database of French university professors active in 2004. Those are confirmed academic inventors since they were all joined by telephone or email and they all confirmed being both university professors and mentioned as inventor in a European patent. This population of academic inventors amounts to 3.84% of the total population of French university scientists (Maîtres de Conférences plus University Professors) in the corresponding scientific disciplines (Lissoni *et al.* 2007).

Out of these 1228 confirmed French academic inventors, we were able to send a questionnaire via email to 1122. For the remaining 106 scientists we were not able to find their email addresses. Moreover 104 email addresses proved to be invalid and 6 respondents answered that they were not concerned by our study, since they were inventors in a European patent before entering academia. Finally, the effective targeted population amounts to 1012 French academic inventors. Out of these 1012 inventors we collected 280 answers, which amount to a response rate of 27.7%.

Tables 3.2, 3.3 and 3.4 give the profiles of the respondents according to their age, gender, academic ranking and scientific disciplines. It also provides similar information for the mother population, which enables us to analyze the representativeness of our sample. The statistics computed for the mother population are based on the 1228 confirmed French academic inventors identified by Lissoni *et al.* (2007).

Table 3.1: From the population of French academic inventors to our sample

French academic inventors identified by Lissoni *et al.* (2007)	1228
No email addresses	- 106
Invalid email addresses	- 104
Not concerned	- 6
French academic inventors who received a questionnaire	1012
Responses collected	280
Response rate: - 27.7% of the scientists to which the questionnaire was sent - 22.8% of the mother population of all the confirmed French academic inventors	

[9] The questionnaire is available on request to the author. It contains 16 questions and was voluntarily kept short in order to increase the response rate. Questions included the following points: In how many priority patents is the professor mentioned as inventor? Who generally is the owner of the patent? What is the policy of the lab in terms of patent? What was the motivation to patent? What direct consequences, either positive or negative, have been experienced? What is the point of view of the researcher about academic patenting?, etc. Furthermore, we are able to cross this information with the scientific discipline of the researcher, his university, his gender and his age.

[10] KEINS is the acronym of "Knowledge based Entrepreneurship: Innovation Networks and Systems".

Table 3.2: Distribution by gender and academic ranking

		Respondents		Mother population	
		Number	**%**	**Number**	**%**
Gender	Male	250	89.3%	1110	90.4%
	Female	30	10.7%	118	9.6%
Academic Ranking	MCF	119	42.8%	443	36.1%
	PU	159	57.2%	785	63.9%

Note: Based on a total of 280 respondents for the gender and 278 respondents for academic ranking.
MCF=Maître de Conférences; PU=University Professor.

Table 3.3: Distribution by age

Respondents			Mother population		
Age	**Number**	**%**	**Age**	**Number**	**%**
More than 65	17	6.1%	More than 65	150	12.2%
60-64	49	17.6%	60-64	258	21%
55-59	43	15.5%	55-59	183	14.9%
50-54	36	12.9%	50-54	148	12.1%
45-49	52	18.7%	45-49	183	14.9%
40-44	48	17.3%	40-44	205	16.7%
35-39	29	10.4%	35-39	90	7.3%
30-34	4	1.4%	30-34	11	0.9%
Total	**278**	**100%**	**Total**	**1228**	**100%**

Note: Based on 278 respondents.

With respect to the representativeness of our sample, we can outline the following points:

- A huge majority of respondents are males (89.3%), which is in line with the mother population (about 90% of French confirmed academic inventors are males).
- There is an over-representation of Maîtres de Conférences in our sample (and therefore an under representation of University professors). This is likely to be correlated with the age variable since most of the time Maîtres de Conférences are younger than University Professors.
- There is an under-representation of aged academic inventors (over 60) (23.7% in the sample of respondents vs. 33.2% in the mother population). This feature of the sample may induce a bias since it is likely that old and young scientists do not have the same experiences about university patenting.
- There is an under-representation of medical sciences in the sample (10.4% in our sample vs. 19.1% in the mother population) and an over-representation of chemical scientists (28.1% vs. 23.1%). The under-representation of medical scientists can probably be explained by the difficulty to reach them. They are usually scientists working full time in hospitals and most of the time we did not have their direct email addresses but the one of their secretaries'.

The issue of multiple patents and the interpretation of the responses

Most academic inventors in our sample are inventors of more than one patent. 80% of our respondents answer that they are inventors in more than one priority patent. Yet, for simplicity's sake and in order to facilitate the treatment of the answers, in many questions we asked respondents to give only one answer. However, it is likely that for those inventors who have been involved in many patent applications, there is not one single appropriate answer because each patent application has its own context and story. Many respondents expressed therefore their frustration of not being allowed to give several answers and considered this as a serious limitation of the questionnaire. For those questions the figure presented here must therefore be considered as being the "average" answer; the one that best takes into consideration all the contexts of the different patent applications.

Table 3.4: Distribution by scientific discipline

	Respondents		Mother population	
DISCIPLINES	**Number of respondents**	**%**	**Number of academic inventors**	**%**
Biological sciences (CNU sections 64 to 69)	**44**	**15.8%**	**165**	**13.4%**
including Biochemistry and molecular biology	17	6.1%	66	5.4%
Cellular biology	12	4.3%	45	3.7%
Chemical sciences (CNU sections 31, 32, 33)	**78**	**28.1%**	**284**	**23.1%**
including Theoretical, physical, analytical chemistry	12	4.3%	50	4.1%
Organic, mineral, industrial chemistry	41	14.7%	140	11.4%
Chemistry of materials	25	9%	94	7.7%
Electronics (CNU section63)	**45**	**16.2%**	**169**	**13.8%**
Medical sciences (CNU sections 43 to 59)	**29**	**10.4%**	**235**	**19.1%**
Pharmaceuticals and drugs (CNU sections 39, 40, 41)	**27**	**9.7%**	**109**	**8.9%**
including Sciences physiquo-chemical and pharmaceutical technologies	12	4.3%	44	3.6%
Drug sciences	11	4%	51	4.2%
Engineering (CNU sections 60, 61, 62)	**37**	**13.3%**	**153**	**12.5%**
including IT engineering and signal treatment	15	5.4%	49	4%
Energy, process engineering	16	5.8%	69	5.6%
Others	**18**	**6.5%**	**113**	**9.2%**
including Materials	10	3.6%	45	3.7%
Total	**278**	**100%**	**1228**	**100%**

Note: Based on 278 respondents.

The issue of hypothetical bias

This study relies on what academic inventors tell us. Yet, scientists' declarations may be biased due to their subjective opinion on university patenting, thus exaggerating or decreasing the merit of university patenting. This "hypothetical bias" is unfortunately a recurrent shortcoming of questionnaire based methodologies and is not specific to our study.

To identify this possible bias, the last question of the questionnaire aimed at collecting the perception of academic inventors about the desirability of patents in science. The question was deliberately subjective in the sense that we did not ask respondents to answer according to their experiences or to objective facts but merely to give their opinion. We provided several statements such as "patenting public research facilitates their commercialisation" or

"patenting public research increases the cost to access scientific knowledge", and we asked respondents to give a mark to the statement, on a Likert scale, according to their degree of agreement: 0 if they totally disagree and 5 if they totally agree. Then, we aggregated the answers in three categories: We considered that the respondent agrees with the statement if he gave a mark equal to 4 or 5, that he disagrees for a mark equal to 0 or 1 and that he is neutral for a mark equal to 2 or 3. Results are displayed in Table 3.5[11].

Overall, respondents are mostly favourable to university patenting. In their vast majority they believe that it has more positive consequences for social welfare than negative ones. Most respondents agree with the positive statements (statements 1 to 6 in Table 3.5), except for the fact that university patenting enable to finance public research. Conversely, respondents usually disagree in their majority with the negative statements (statements 7 to 10 in Table 3.5). The sole negative point for which there is not a majority of respondents who disagree is the fact that university patenting may decrease the dissemination of scientific research.

Table 3.5: Perception of university patenting by respondents

	According to you, university patenting:	**Disagree**	**Neutral**	**Agree**
1	Facilitate the commercialization of academic inventions	24.8%	22.4%	52.8%
2	Increase the incentives of scientists to do research	64.7%	21.9%	13.4%
3	Increase the bargaining power of universities in front of Industrialists	18.7%	26.6%	54.7%
4	Facilitate the development of collaborations between universities and firms	20.1%	30.6%	49.3%
5	Enable to finance public research	40.3%	32.0%	27.7%
6	Increase the visibility and credibility of scientists	12.9%	28.1%	59.0%
7	Decrease the diffusion and dissemination of academic Research	34.5%	39.2%	26.3%
8	Reduce incentives to do basic, non patentable research	65.5%	23.4%	11.1%
9	Reduce trust and thus decrease collaboration and interaction among scientists	69.4%	22.3%	8.3%
10	Increase the cost to access scientific knowledge	56.8%	29.5%	13.7%

Note: Based on 278 responses.

Those results can be compared with the work done by Davis *et al.* (2008), which is the only comparable study we know. These authors assess and try to explain the perception of life science scientists in Denmark with respect to university patenting. They ask two questions to the respondents: whether or not they believe that university patenting had a negative impact (1) on the freedom to choose research and (2) on the norms of open science. Overall, they find out that 27% of respondents believe that university patenting has a negative impact on the freedom to choose research (58% believe it has a neutral effect and 15% a positive effect) and 41% believe that it has a negative impact on the norms of open science (49% believe it has a neutral effect and 10% a positive effect).

[11] Those figures must be interpreted with care since we assigned a 0 each time a respondent did not give a mark to a statement (let a blank). This may bias some answers downwards. This point was clearly stated in the questionnaire. But, probably due to lack of time, some respondents still gave a mark only to one or two statements out of the 10 that were listed and left a blank for all the others. We therefore assigned a 0 for all the statements that were not marked although it is likely that in the mind of the respondents they may have been ranked differently. However, the bias induced is likely to remain low since respondents probably neglected to give a mark only to statements that did not appear relevant to them and hence for which they disagreed.

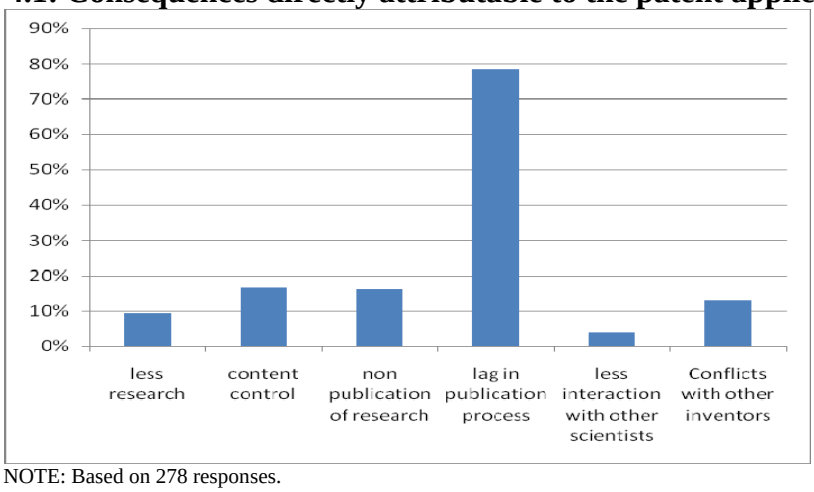
As a matter of comparison, in our sample only 8% of the respondents believe that university patenting reduces trust and diminishes interactions among scientists. Respondents seem therefore to have mostly a positive, and sometimes enthusiastic, image of university patenting. This feature must be kept in mind when analysing certain results of the survey.

4. Consequences of university patenting: Key findings

4.1 University patenting and the dissemination of academic knowledge

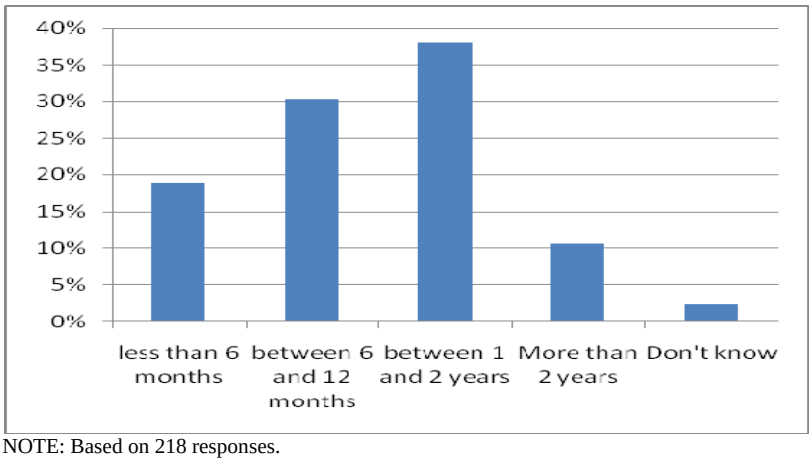
Our findings suggest that university patenting almost systematically induces a lag in the publication process. In a huge majority of cases researchers assert that they are obliged to postpone the publication of their research in order to proceed to the patent application. More precisely, 218 scientists out of 278 respondents (78%) acknowledge a lag in the publication process directly attributable to the patent application. Furthermore, 46 scientists (17% of respondents) acknowledge a control over the content of their publications by a partner firm, which has the right to deny the publication or to modify the content. Finally 45 scientists (16% of respondents) also acknowledge that the patent application obliged them to renounce to publish their research (Figure 4.1).

Figure 4.1: Consequences directly attributable to the patent application



NOTE: Based on 278 responses.

Figure 4.2: Estimated lag in publication date directly attributable to the patent application



NOTE: Based on 218 responses.

Out of the 218 academic inventors who have acknowledged a lag in their publication process, about one half (106, which amounts to 49% of the respondents who acknowledge a delay) state that this delay exceeded 1 year (Figure 4.2). In many cases it seems therefore that the lag is not marginal and can affect the pace of scientific research. One year can sometimes represent a very long time at the scale of scientific research. Furthermore, the length of the lag does not seem to be discipline specific. For instance, the distribution of scientists who acknowledge a lag superior to 1 year is quite homogeneous over scientific disciplines.

Our findings suggest that university patent may impede seriously the diffusion of scientific knowledge. It may affect the speed of the diffusion as well as the content of publications[12]. This finding contributes to feed the debate about the possible extension to European countries of the grace period that exists in the US. Such a grace period, which allows scientists to publish their research without renouncing to a patent within a period of one year after the first publication, would indeed certainly contribute to speed the diffusion of patentable academic research (Franzoni and Scelleto 2007).

4.2 University patenting and the commercialization of academic inventions

With respect to the commercialization of university inventions, our survey tends to confirm the Bayh-Dole hypothesis only in some technological fields. 42% of the respondents (114 out of the 270 respondents to the question) stated that one of their patented inventions had been industrialized or commercialized by a firm. Out of these 114 respondents, more than one half considered that the patent played a fundamental role in the process of transferring the technology. More precisely, 54% answered that without the patent application their invention would not have been exploited (see Table 4.1). Furthermore, 25% considered that although their invention would have been exploited should a patent not have been applied for, the patent application helped the commercialization or the industrialization of the invention. Overall three quarters of the respondents consider therefore that patents helped the industrial exploitation of university research and only 7% think that the fact that their invention was patented did not play any role to help the transfer of the invention.

This issue of the corporate exploitation of university research is very discipline sensitive. Table 4.2 shows the results displayed by sectors. The first column indicates the number of respondents who considered that their invention would not have been exploited by a firm without a patent. Then, we divided this number by the total number of respondents who said that one of their inventions had been exploited by a firm (column 3). The result is displayed in the fourth column. This ratio is particularly high for biology and pharmaceuticals. With regard to the former, according to the respondents three quarters of the inventions exploited in industry would not have been transferred without patents. This ratio goes up to 100% in pharmaceuticals and drugs. This means that according to the respondents, in this sector all the academic inventions that have been transferred to the industry would have remained on the shelves of the university had they not been patented. The ratio is much lower in engineering sciences, where almost three quarters of the commercialized inventions would have been transferred even without patents.

[12] Yet, this finding must be interpreted with care since one of the primary goals of patents is also to help knowledge dissemination. For instance, one of the respondents mentioned that: “In the field of chemical sciences, a patent is a genuine publication. Some of my patents in the past have not been followed by publications in scientific journals because they were so complete that a publication would not have helped to diffuse more knowledge […] 95% of the content of publications in scientific journals could not have been patented, not due to the lack of industrial application, which is the argument usually put forward, but due to a lack of real novelty”. This comment was corroborated by other respondents.

Table 4.1: The effect of university patents on the corporate exploitation of university research

Question: If your patented invention has been commercialized or industrialized, did the patent play a role within this technology transfer? (only one possible answer)	Number of respondents	%
Yes, without the patent application the invention would not have been exploited	62	54%
Yes, without the patent application the invention would have been exploited but the patent has facilitated this exploitation	28	25%
No, no role at all	8	7%
I don't know	16	14%
Total	114	100%

Note: Based on 114 responses. This amounts to the academic inventors of an invention that has been industrialized or commercialized (42% of respondents). The remaining 58% did not experience the commercialization or industrialization of any of their patented inventions.

Table 4.2: Distribution by scientific disciplines of scientists who consider that their invention would not have been exploited should a patent not have been granted

	Number of 'yes, patent was necessary'	% of 'yes'	Number of invention exploited	Ratio 'Yes' over number of invention exploited	Total number of respondents	Ratio of 'yes' over number of respondents
Biological sciences	14	25.9%	19	73.7%	44	13.6%
Chemical sciences	15	27.8%	34	44.1%	78	23.1%
Electronics	7	13%	16	43.8%	45	20.0%
Medical sciences	8	14.8%	14	57.1%	29	10.3%
Pharmaceuticals and drugs	11	20.4%	11	100%	27	33.3%
Engineering	4	7.4%	14	28.1%	37	13.5%
Others	3	5.6%	6	50%	18	22.2%
Total	62	100%	114		278	

Our work brings therefore new insights with regard to the Bayh-Dole hypothesis, which assumes that patenting university research helps the commercialization and use of these researches in industry. This hypothesis seems to be especially relevant in life science sectors such as biology, pharmaceuticals and medical sciences, but less so in engineering.

4.3 University patenting and the culture of "open science"

Our study brings only limited evidence with respect to the consequences of university patenting on the culture of "open science". On the one hand, only a very low proportion of respondents consider that their participation in a patent application decreased the rate of their interactions with the rest of the scientific community (Figure 4.1). Only 11 scientists out of 278 respondents (4%) consider this to be true. The fact that academic patenting does not seem to affect significantly interactions among researchers also emerges when one asks researchers directly about their perception of university patents. Only 8% of respondents consider that university patenting reduces trust and diminishes collaborations and interactions among scientists. But, on the other hand, 36 scientists out of 278 respondents (13%) confess that their participation in a patent has somehow triggered some conflicts with other members of the

scientific community or with industrial partners (Figure 4.1). This last finding suggests therefore that patents are not always neutral and that they can be a potential source of tension within scientific communities, decreasing the necessary trust to foster collective research.

Table 4.3: Perception of academic inventors by scientific colleagues

Question: How was your participation to a patent application perceived by your scientific colleagues? (only one possible answer)	Number of respondents	%
Rather positive image	148	53%
Indifference	77	28%
Rather negative image	15	5%
I don't know	38	14%
Total	278	100%

Note: Based on 278 responses.

Furthermore, our study does not provide evidence to sustain the hypothesis that academic inventors are ostracized among the scientific community. Most scientists think that their patent application was positively considered by their scientific colleagues (53%). Only 15 inventors out of the 278 respondents (5%) think that their implication in a patent application was badly perceived within their scientific environment (Table 4.3).

4.4 University patenting and incentives to do basic research

Our study suggests that university patent may not be neutral with respect to the agenda of scientists. We asked academic inventors whether or not the possibility to be granted patents had any influence over their research agenda. Results are displayed in Table 4.4. Almost 20% of the respondents acknowledged that they tend to orient their research in areas where they know they will be able to get patents. This may indeed suggest that, at least for some researchers, the possibility to get patents encourages them to do less basic research and more applied research. Furthermore, consequences of academic patenting on the nature of academic research are very sector specific. Table 4.5 shows that this issue may be specifically relevant in chemical sciences and in pharmaceuticals and drugs and much less in engineering and biological sciences.

Table 4.4: Influence of university patents over scientists' research agenda

Question: Did the possibility to be granted patents influence the nature of your research? (only one possible answer)	Number of respondents	%
Yes, I try to orient my research in fields where I know it will be possible to apply for patents	54	19.4%
No	215	77.3%
I don't know	9	3.3%
Total	278	100%

Note: Based on 278 responses. We voluntarily did not use the words "applied research" and "basic research" in this question in order to dismiss any misunderstanding from respondents.

Again, this interpretation must be taken with care since, as noticed by some respondents, behind any patent application there is an important amount of basic research. Another finding urges us to interpret this finding carefully: When researchers are asked whether or not university patents "decrease incentives to do basic research" they almost unanimously disagree with this statement. Only 11% agree (Table 3.5). This may suggest that whereas some researchers indeed decide their research agenda according to patent possibility, they do

not consider that this induces a reduction of their activity in basic research. A possible explanation of this feature is the increasingly blurred frontier between basic and applied research in some technological fields.

Table 4.5: Distribution by scientific disciplines of scientists who acknowledge orienting their research towards patentable activities

	'yes', patents influence research agenda	% of 'yes'	Number of respondents	Ratio of 'yes' over number of respondents
Biological sciences	6	11.1%	44	13.6%
Chemical sciences	18	33.3%	78	23.1%
Electronics	9	16.7%	45	20.0%
Medical sciences	3	5.6%	29	10.3%
Pharmaceuticals and drugs	9	16.7%	27	33.3%
Engineering	5	9.3%	37	13.5%
Others	4	7.4%	18	22.2%
Total	54	100%	278	

Related to the question of the effect of academic patenting on the research agenda of scientists, 26 respondents (9,4%) also considered that the patent application led them to reduce the amount of time spent to do research (Figure 4.1). Although we did not ask researchers to explain this reduction of their activity of research, open comments made by some respondents suggest that this is mainly due to the administrative burden and to the necessity to follow the invention after it has been patented (bargaining with industrialists, time spent to explain the invention, etc.).

4.5 University patenting and access to upstream research

With respect to this issue, our findings are not as optimistic as Cohen and Walsh's (2003). A significant share of respondents acknowledges having been obliged to reorient their research due to patent problems. Almost one quarter of the respondents (68, which represents 24% of respondents) acknowledge having been obliged to change their research agenda to get round patents held by other inventors. Yet, we do not know whether those scientists were obliged to change their research agenda due to university patents or due to corporate patents. Moreover, 14% of the respondents also confess having already been involved at least once in a patent litigation. These results are displayed in Table 4.6 and 4.7.

Table 4.6: Access to upstream research

Question: Have you already been disturbed in your research by patents held by other inventors?	Number of respondents	%
Yes, I have already been obliged to reorient my research in order to get round a patent held by a tierce organization	66	24%
Yes, my lab has already been obliged to buy licenses to other inventors in order to be allowed to pursue research in a given technological domain	2	0.7%
No	207	75.3%
Total	275	100%

Note: Based on 275 responses.

Table 4.7: Academic inventors involved in patent litigations

Question: Have you already been implied in a patent litigation (Trial, etc.)?	Number of respondents	%
Yes	39	14%
No	240	86%
Total	279	100%

Note: Based on 279 responses.

Again, the issue of patents as impeding access to existing knowledge is very sector specific. Table 4.8 indicates that this question is particularly relevant in electronics and pharmaceutical and drugs, while it is less important in Biology. In this latter field we find nevertheless that 15.9% of respondents acknowledge having been obliged to reorient their research in order not to infringe patents held by others. In electronics this shares goes up to 33.3% and in pharmaceuticals up to 37%.

Overall, these results suggest that patents may in some cases be serious impediments to upstream research. This stands in sharp contrast with the work of Cohen and Walsh in the field of biomedical sciences. Yet, respondents do not seem to worry too much about the consequences of university patenting on the access to existing inventions. Only 13.7% of respondents believe that patents increase the cost of access to existing knowledge (Table 3.5).

Table 4.8: Distribution by scientific discipline of scientists involved in patent litigation and disturbed in their research by patents held by other inventors

	'yes', reorientation of research (1)	Number of Respondents (2)	(1) over (2)	'yes', involved in patent litigation (3)	(3) over (2)
Biological sciences	7	44	15.9%	5	11.4%
Chemical sciences	21	78	26.9%	11	14.1%
Electronics	15	45	33.3%	6	13.3%
Medical sciences	6	29	20.7%	5	17.2%
Pharmaceuticals and drugs	10	27	37%	5	18.5%
Engineering	8	37	21.6%	1	2.7%
Others	1	18	5.6%	6	33.3%
Total	68	278		39	

5. Conclusion

This paper used a new source of information to explore the consequences of university patenting. Via a survey conducted in April and May 2008, we asked questions directly to academic inventors, i.e. to scientists who have been involved in patenting activities. Those are indeed the best persons to know about the effects their patents have had on their research and publication activities, the commercialization of their inventions, the granting of funds, etc. Overall we collected information on 280 academic inventors. Of course, like all questionnaire-based studies, results must be taken with care due to multiple possible biases. Our results are not based on perfectly objective facts but on what respondents have told us. Yet, in the case of university patenting, where objective figures are rare, this nevertheless

allows us to provide a rich bundle of new insights. Relying on this original and, to our knowledge, unique dataset our work outlines the following results:

- University patenting almost systematically induces a lag in the publication of academic research. About 80% of the respondents acknowledge a delay in their publication directly attributable to the patenting process. Furthermore in half the cases this lag is longer than 1 year. Some respondents also explain that their patenting activities prevent them from publishing their research or led to a control by industrial partners over the content of their publication. This result may call for an extension to European countries of the grace period that exists in the US, at least for academic patents (Franzoni and Scellato, 2007).
- University patenting can be helpful to transfer inventions from universities to industry in certain sectors (the so-called Bayh-Dole Hypothesis). About 40% of the respondents say that one of their inventions has been used by a firm. More than half of these respondents who have experienced technology transfer also think that the transfer would not have been realized without the existence of the patent. Patents are specifically helpful to enable the transfer of university inventions to industry in fields such as pharmaceuticals and biology.
- Our study provides only limited evidence with respect to the effect of university patent on interactions and exchanges within the scientific community. Yet, the little evidence we have suggests that university patenting does not seem to interfere too much with the open science culture (the issue of the publication lag put apart). For instance, a huge majority of respondents think that their patenting activity is rather well perceived by their colleagues.
- University patenting can increase the cost of accessing upstream research and can block research in some technological fields. About 25% of the respondents confess that they have already been obliged to re-orient their research because of risks of infringements.
- University patenting can in some cases lead to a modification of the research agenda of scientists and encourage some of them to do more applied, patentable research and less basic, non-patentable research. 20% of the respondents acknowledge that university patents affect their research agenda. More specifically, the possibility to be granted patents induces them to undertake research in patentable areas rather than in non-patentable areas. Yet, this result must be taken with care since patentable research may not necessarily be done to the detriment of basic research.

The purpose of this paper was to display the first descriptive statistics of our survey on the consequences of university patenting. This new and rich dataset opens the way for many future works: First, an econometric treatment should allow us to deepen the analysis. Second, for some questions, it is necessary to balance the answers of our respondents with those of a control sample (scientists who are not patent inventors). Third, international comparisons may enable to enrich our insights.

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